

Claims

1. *(Currently amended)* A magnetic recording disk drive comprising:
a magnetic recording disk comprising a substrate and a laminated magnetic recording layer on the substrate and having a lower ferromagnetic layer, an upper ferromagnetic layer and a nonferromagnetic spacer layer between the lower and upper ferromagnetic layers, at least one of the lower and upper ferromagnetic layers being an antiferromagnetically coupled (AFC) layer, the AFC layer comprising a first ferromagnetic film, a second ferromagnetic film and an antiferromagnetically coupling film located between the first and second ferromagnetic films and having a thickness and composition to provide antiferromagnetic exchange coupling of the first and second ferromagnetic films;
an inductive write head for generating a magnetic field to alter the magnetization directions in regions of the lower and upper ferromagnetic layers, the magnetization directions of the lower and upper ferromagnetic layers in said regions being parallel; and
a heater for directing heat to the region of the lower ferromagnetic layer exposed to the magnetic field from the write head.
2. *(Canceled)*
3. *(Currently amended)* The disk drive of claim 1 ~~2~~ wherein only the lower ferromagnetic layer is an AFC layer.

4. *(Original)* The disk drive of claim 3 wherein the first ferromagnetic film of the AFC layer has a thickness t_1 and a magnetization M_1 and is adjacent the nonferromagnetic spacer layer, the second ferromagnetic film of the AFC layer has a thickness t_2 and a magnetization M_2 , and wherein the magnetic moment per unit area ($M_2 \times t_2$) of the second ferromagnetic film is less than the magnetic moment per unit area ($M_1 \times t_1$) of the first ferromagnetic film.

5. *(Currently amended)* The disk drive of claim 1 2 wherein the antiferromagnetically coupling film of the AFC layer is formed of a material selected from the group consisting of ruthenium (Ru), chromium (Cr), rhodium (Rh), iridium (Ir), copper (Cu), and their alloys.

6. *(Original)* The disk drive of claim 1 wherein the first and second ferromagnetic layers are made of a material selected from the group consisting of Co, Fe, Ni, and their alloys.

7. *(Original)* The disk drive of claim 1 further comprising an underlayer located on the substrate between the substrate and the magnetic recording layer.

8. *(Original)* The disk drive of claim 1 further comprising a protective overcoat formed over the magnetic recording layer.

9. *(Currently amended)* ~~The disk drive of claim 1 wherein the heater is an electrically resistive heater~~ A magnetic recording disk drive comprising:
_____ a magnetic recording disk comprising a substrate and a laminated magnetic recording layer on the substrate and having a lower ferromagnetic layer, an upper ferromagnetic layer and a nonferromagnetic spacer layer between the lower and upper ferromagnetic layers;
_____ an inductive write head for generating a magnetic field to alter the magnetization directions in regions of the lower and upper ferromagnetic layers, the magnetization directions of the lower and upper ferromagnetic layers in said regions being parallel; and
_____ an electrically resistive heater for directing heat to the region of the lower ferromagnetic layer exposed to the magnetic field from the write head.

10. *(Original)* The disk drive of claim 1 wherein the heater is a laser.

11. *(Original)* The disk drive of claim 1 further comprising a slider for supporting the inductive write head.

12. *(Original)* The disk drive of claim 11 wherein the heater is supported on the slider.

13. *(Currently amended)* ~~The disk drive of claim 1 wherein the upper ferromagnetic layer is formed of a material having an intrinsic coercivity substantially higher than the intrinsic coercivity of the lower ferromagnetic layer~~ A magnetic recording disk drive comprising:

a magnetic recording disk comprising a substrate and a laminated magnetic recording layer on the substrate and having a lower ferromagnetic layer, an upper ferromagnetic layer and a nonferromagnetic spacer layer between the lower and upper ferromagnetic layers, the upper ferromagnetic layer being formed of a material having an intrinsic coercivity substantially higher than the intrinsic coercivity of the lower ferromagnetic layer;

an inductive write head for generating a magnetic field to alter the magnetization directions in regions of the lower and upper ferromagnetic layers, the magnetization directions of the lower and upper ferromagnetic layers in said regions being parallel; and

a heater for directing heat to the region of the lower ferromagnetic layer exposed to the magnetic field from the write head.

14. *(Currently amended)* ~~The disk drive of claim 1 wherein the lower ferromagnetic layer is located a distance from the write head such that the write field at the lower ferromagnetic layer is less than the intrinsic coercivity of the lower ferromagnetic layer in the absence of heat from the heater~~ A magnetic recording disk drive comprising:
a magnetic recording disk comprising a substrate and a laminated magnetic recording layer on the substrate and having a lower ferromagnetic layer, an upper ferromagnetic layer and a nonferromagnetic spacer layer between the lower and upper ferromagnetic layers;
an inductive write head for generating a magnetic field to alter the magnetization directions in regions of the lower and upper ferromagnetic layers, the magnetization directions of the lower and upper ferromagnetic layers in said regions being parallel; and
a heater for directing heat to the region of the lower ferromagnetic layer exposed to the magnetic field from the write head; and wherein the lower ferromagnetic layer is located a distance from the write head such that the write field at the lower ferromagnetic layer is less than the intrinsic coercivity of the lower ferromagnetic layer in the absence of heat from the heater.

15. *(Original)* A magnetic recording disk drive comprising:
an inductive write head for generating a magnetic field;
a magnetic recording disk comprising a substrate and a laminated magnetic recording layer on the substrate and having a lower ferromagnetic, an upper ferromagnetic layer and a nonferromagnetic spacer layer between the lower and upper ferromagnetic layers, the upper ferromagnetic layer being located a distance S from the write head and the lower ferromagnetic layer being located a distance $S + X$ from the write head, the lower ferromagnetic layer having an intrinsic coercivity enabling magnetization reversal when exposed to the magnetic field from the write head at a distance S but inhibiting magnetization reversal when exposed to the magnetic field from the write head at a distance $S + X$; and
means for heating the lower ferromagnetic layer to lower the intrinsic coercivity to thereby enable magnetization reversal when exposed to the magnetic field from the write head at a distance $S + X$.

16. *(Original)* The disk drive of claim 15 wherein at least one of the lower and upper ferromagnetic layers is an antiferromagnetically coupled (AFC) layer, the AFC layer comprising a first ferromagnetic film, a second ferromagnetic film and an antiferromagnetically coupling film located between the first and second ferromagnetic films and having a thickness and composition to provide antiferromagnetic exchange coupling of the first and second ferromagnetic films.

17. *(Original)* The disk drive of claim 16 wherein only the lower ferromagnetic layer is an AFC layer.

18. *(Original)* The disk drive of claim 17 wherein the first ferromagnetic film of the AFC layer has a thickness t_1 and a magnetization M_1 and is adjacent the nonferromagnetic spacer layer, the second ferromagnetic film of the AFC layer has a thickness t_2 and a magnetization M_2 , and wherein the magnetic moment per unit area ($M_2 \times t_2$) of the second ferromagnetic film is less than the magnetic moment per unit area ($M_1 \times t_1$) of the first ferromagnetic film.

19. *(Original)* The disk drive of claim 15 wherein the heater is an electrically resistive heater.

20. *(Original)* The disk drive of claim 15 wherein the heater is a laser.

21. *(Original)* The disk drive of claim 15 further comprising a slider for supporting the inductive write head.

22. *(Original)* The disk drive of claim 21 wherein the heater is supported on the slider.

23. *(Original)* The disk drive of claim 15 wherein the upper ferromagnetic layer is formed of a material having an intrinsic coercivity substantially higher than the intrinsic coercivity of the lower ferromagnetic layer.